ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 612289

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental [X] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	B. C. Simpson, LMHC, R2-12, 373-5915	[] Yes [X] No	7/28/97
	6. Project Title/No./Work Order No. Tank 241-C-201	7. Bldg./Sys./Fac. No. NA	8. Approval Designator NA
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-WM-ER-476, Rev. 0B	10. Related ECN No(s). NA	11. Related PO No. NA

12a. Modification Work	12b. Work Package No.	12c. Modification Work Complete	12d. Restored to Original Condition (Temp. or Standby ECN only)
[] Yes (fill out Blk. 12b) [X] No (NA Blks. 12b, 12c, 12d)	NA	NA Design Authority/Cog. Engineer Signature & Date	NA Design Authority/Cog. Engineer Signature & Date

13a. Description of Change 13b. Design Baseline Document? [] Yes [X] No

Add Appendix E, Evaluation to Establish Best-Basis Inventory for Single-Shell Tank 241-C-201.

14a. Justification (mark one)

Criteria Change	[]	Design Improvement	[]	Environmental	[]	Facility Deactivation	[]
As-Found	[X]	Facilitate Const	[]	Const. Error/Omission	[]	Design Error/Omission	[]

14b. Justification Details

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities. As part of this effort, an evaluation of available information for single-shell tank 241-C-201 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.

15. Distribution (include name, MSIN, and no. of copies)

Central Files	A3-88	K. M. Hall	R2-12
DOE Reading Room	H2-53	K. M. Hodgson	R2-11
TCSRC	R1-10	R. T. Winward	H5-49
File	H5-49		
B. C. Simpson	R2-12	R. D. Schreiber	R2-12
M. J. Kupfer	H5-49		
M. D. LeClair (3)	H0-50		

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16. Design Verification Required	17. Cost Impact				18. Schedule Impact (days)	
	ENGINEERING		CONSTRUCTION			
[] Yes	Additional	[] $	Additional	[] $	Improvement	[]
[X] No	Savings	[] $	Savings	[] $	Delay	[]

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[]
Environmental Report	[]	Inspection Plan	[]		[]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision
NA		

21. Approvals

	Signature	Date		Signature	Date
Design Authority			Design Agent		
Cog. Eng. M. J. Kupfer	M J Kupfer	7-29-97	PE		
Cog. Mgr. K. M. Hodgson	K.M. Hodgson	7-30-97	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other R. D. Schreiber	Ruth D. Schreiber	7/30/97	Other		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

Tank Characterization Report for Single-Shell Tank 241-C-201

B. C. Simpson and R. T. Winward (Meier Associates)
Lockheed Martin Hanford Corporation, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

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Abstract: An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities. As part of this effort, an evaluation of available information for single-shell tank 241-C-201 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.

Janis Bishop 8-20-97
Release Approval Date

Approved for Public Release

RECORD OF REVISION

(1) Document Number: WHC-SD-WM-ER-476

Page X 1

(2) Title
Tank Characterization Report for Single-Shell Tank 241-C-201

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	(6) Cog. Mgr. Date
0	(7) Initially released 08/03/95 on EDT-613106.	R.D. Schreiber	J.G. Kristofzski
RS 0-A	Incorporate per ECN-623845.	L.M. Sasaki	J.G. Kristofzski
		L M. Sasaki	JG Kristofzski for JK 9/1/95
0-B RS	Incorporate per ECN-625692.	S.E. Kelly	J.G. Kristofzski
		S E Kelly	JG Kristofzski for JK 9/18/95
OC RS	Incorporate per ECN-612289	M. J. Kupfer	K. M. Hodgson
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APPENDIX E

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-C-201

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APPENDIX E

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-C-201

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of available information for single-shell tank 241-C-201 was performed, and a best-basis inventory was established. This work, detailed in the following sections, follows the methodology that was established by the standard inventory task. The following evaluation provides a best-basis inventory estimate for chemical and radionuclide components in tank 241-C-201.

E1.0 CHEMICAL INFORMATION SOURCES

Data sources for tank 241-C-201 include the following:

- Appendix B provides mean characterization results and inventory estimates from a core sample obtained in 1978 (Horton 1978). The sample had limited information collected from it, and no associated quality control assays.

- Two auger samples were subsequently obtained for safety screening analysis in 1995 (Schreiber 1995); however, the data obtained did not contribute to the chemical information available.

- The Hanford Defined Waste (HDW) model (Agnew et al. 1997a) provides tank contents estimates, derived from process flowsheets and waste volume records.

E2.0 COMPARISON OF COMPONENT INVENTORY VALUES

The 1978 sample-based inventory estimate and the inventory estimate from the HDW model (Agnew et al. 1997a) for tank 241-C-201 are shown in Table E2-1 and E2-2. Each estimate, however, has a different density basis.

The HDW inventory estimates use a waste volume of 7.6 kL (2 kgal), and a waste density of 1.56 g/mL. The sample-based inventory uses a volume of 7.6 kL (2 kgal), and a measured bulk density of 1.16 g/mL as bases. Because of the difference between the two estimates for the mass basis (relative percent difference = 29.4 percent), many differences between the sample-based and HDW model inventories are observed.

Estimates obtained from the two methods for most analytes vary by a factor of two or more. The chemical species in this section are reported without charge designation per the best-basis inventory convention.

Table E2-1. Sample and Hanford Defined Waste Model-Based Inventory Estimates for Nonradioactive Components in Tank 241-C-201.

Analyte	Sample inventory estimate[a] (kg)	HDW model inventory estimate[b] (kg)	Analyte	Sample inventory estimate[a] (kg)	HDW model inventory estimate[b] (kg)
Al	14.1	0	NO_3	291	17.3
Bi	NR	0	OH	44.1[c]	1,840
Ca	NR	13.4	Pb	NR	119
Cl	17.6	5.62	PO_4	1,290	144
Cr	1.18	1.57	Si	32.9	0.181
F	4.39	0	SO_4	NR	53.0
Fe	547	1,220	Sr	NR	0
K	3.52	10.9	TIC as CO_3	176	429
NH_3	NR	16.2	TOC	18.2	76.8
Na	238	599	U_{TOTAL}	0.583	1,580
Ni	70.5	41.2	Zr	NR	0
NO_2	8.82	157	H_2O (Wt%)	68.0	45.4
			Density (kg/L)	1.16	1.56

HDW = Hanford Defined Waste
NR = Not reported
[a] Derived from Appendix B
[b] Agnew et al. (1997a)
[c] Obtained from soluble portion only.

Table E2-2. Sampling and Hanford Defined Waste Model-Based Inventory Estimates for Radioactive Components in Tank 241-C-201.

Analyte	Sampling inventory estimate[a] (Ci)	HDW model inventory estimate[b] (Ci)
^{137}Cs	67.5	9.08
^{90}Sr	360	30,700
$^{239/240}Pu$	20	16.53
Total α	47[c]	NR

HDW = Hanford Defined Waste
NR = Not reported
[a] Derived from Appendix B for sample obtained in 1978
[b] Agnew et al. (1997a), decayed to January 1, 1994
[c] Based on 1995 auger samples.

E3.0 COMPONENT INVENTORY EVALUATION

The following evaluation of tank contents is performed in order to identify potential errors and/or missing information that would influence the sample-based and HDW model component inventories. The types and volumes of solids accumulated in tank 241-C-201 reported by various authors is compiled in Tables E3-1, E3-2, and E3-3.

E3.1 CONTRIBUTING WASTE TYPES

The process history documents indicate the tank received mostly metal waste (MW) and Hot Semiworks/Strontium Semiworks (HS/SSW) waste while the tank was active. Tank 241-C-201 went into service in 1947 receiving metal waste through a diversion box (Agnew et al. 1997b). Metal waste sludge, which originated from uranium fuel dissolution in the bismuth phosphate process, was then sluiced from waste storage tanks, and the uranium in the waste was separated from fission products using a solvent extraction process based on tri-butyl phosphate. Most of the metal waste was removed from the tank in 1954 during the uranium recovery campaign. The tank was declared empty in March 1954, however that classification does not preclude the presence of a small insoluble heel. For the remainder of its service life, from 1955 to 1976, tank 241-C-201 received and stored HS/SSW (Agnew et al.1997b). Because of the supporting information from process history, for purposes of this evaluation, the tank inventory is considered to be entirely HS/SSW.

Table E3-1. Waste Inventory of Tank 241-C-201 (Hanlon 1997).

Waste	Volume (kL)	Volume (kgal)
Sludge	7.6	2
Saltcake	0	0
Supernatant	0	0
Drainable Interstitial Liquid	0	0
Total Waste	7.6	2

Table E3-2. Expected Solids for Tank 241-C-201.

Reference	Waste Type
Anderson (1990)	MW, HS/SSW
SORWT Model (Hill et al. 1995)	HS/SSW
WSTRS (Agnew et al. 1997b)	MW, HS/SSW
HDW Model (Agnew et al. 1997a)	MW, HS/SSW

HDW = Hanford Defined Waste
HS/SSW = Hot Semiworks/Strontium Semiworks
MW = Metal waste
SORWT = Sort on Radioactive Waste Type
WSTRS = Waste Status and Transaction Record Summary.

Table E3-3. Hanford Defined Waste Model Solids for Tank 241-C-201.

HDW solids layer	kL	kgal
MW	3.8	1
HS/SSW	3.8	1
Total HDW Volume	7.6	2

HDW = Hanford Defined Waste
HS/SSW = Hot Semiworks/Strontium Semiworks
MW = Metal waste.

E3.2 EVALUATION OF PROCESS FLOWSHEET INFORMATION

Tank 241-C-201 contains a small amount of sludge. Technical flowsheet information for the HS/SSW stream is provided in Table E3-4. The comparative HDW is also provided in this table. The purpose of the comparison is to evaluate the accuracy, completeness, and reliability of the historical data.

Table E3-4. Technical Flowsheet and Hanford Defined Waste Compositions for Hot Semiworks/Strontium Semiworks.

Analyte	Flowsheet HS/SSW[a] (mol/L)	HDW[b] HS/SSW (mol/L)
Ba	2.0 E-04	NR
Ca	0.0049	0.0049
Fe	0.03	0.07
Ce	0.0017	NR
Acetate	1.34	0.51
K	0.078	0.089
Na	4.9	2.21
OH	1.32	0.33
NO_3	2.1	1.08
Pb	0.034	0.0034
Rare Earths	0.0069	NR
Sr	5.0 E-04	NR

HDW = Hanford Defined Waste
HS/SSW = Hot Semiworks/Strontium Semiworks
[a] Hill et al. (1995) and Appendix C of this report
[b] Agnew et al. (1997a).

E3.3 ENGINEERING EVALUATION OF TANK SAMPLE INFORMATION

An estimate of the waste inventory in tank 241-C-201 will be derived using information independent from the composition information contained in Horton (1978).

E3.3.1 Hot Semiworks/Strontium Semiworks Composition Estimate

Table E3-5 provides an estimate of the waste composition in tank 241-C-201 using the waste composition from data extracted from the flowsheet. Two in-tank photographs of tank 241-C-201 (Section 2) show that the surface changed considerably in two years. The surface went from being a moist, dark blue/black material with obvious patches of standing liquid to a dried and cracked surface of bright yellow material with a black powdery crust, with no apparent moisture and no standing liquid. The current differential scan calorimetry thermogravimetric analysis (DSC/TGA) information reflects this observation, with percent water measurements of 10 to 11 percent.

Table E3-5 also shows data for tank 241-C-201 from the 1978 sampling event. The results are for a single composite. Sample recovery appears to have been average to poor and only one riser was sampled. The core sample analysis were not documented to current QC requirements, however there is no reason to believe that the samples were not analyzed using good laboratory practice. The tank's process history, inspection of the available data, and visual observation of the current tank photos suggest that spatial heterogeneity may be significant for this tank.

The 1995 analysis was conducted on 2 auger samples. The results do not contain any relevant chemical species information, because only DSC/TGA, total organic carbon (TOC), and total alpha activity information was collected (Schreiber 1995).

E3.3.2 Basis For Sample Calculations Used In This Independent Evaluation

The total volume of waste that passed through these tanks is not well quantified and the amount of each contributing waste type is unknown. The HDW model inventory is based on assumptions regarding the physical behavior and composition of the waste types identified from process history, which have not been confirmed. This tank was recently sampled, but very little analytical data were collected. Thus, that sampling event is not useful in this process (Schreiber 1995). Although process information is not complete, Hill et al. (1995) gives a generalized flowsheet for SSW/HS waste that was used to estimate selected analyte inventories. Horton (1978) is used extensively as the sample-based estimate, and Hanlon (1997) provides the volume basis.

E3.3.3 Assumptions

The assumptions and observations are based upon best technical judgement pertaining to parameters that can significantly influence tank inventories. These parameters include: (1) correct predictions of contributing waste types, (2) accurate predictions of model flowsheet conditions, fuel processed, and waste volumes, (3) accurate predictions of component solubilities, and (4) accurate predictions of physical parameters such as density, percent solids, void fraction (porosity), etc.

As necessary, the assumptions used can be modified to provide a basis for identifying potential errors and/or missing information that could influence either or both sample- and model-based inventories. The simplified assumptions and observations use for predicting the inventory of several analytes in tank 241-C-201 are as follows:

1. Only HS/SSW introduced into tank 241-C-201 contributed to solids formation.

2. Radiolysis of NO_3 to NO_2 and any addition of NO_2 to the waste in tank 241-C-201 for corrosion control purposes are not accounted for in this independent assessment.

3. All Ba, Ca, Ce, Fe, Pb, and Sr from the HS/SSW flowsheet precipitate.

4. The currently accepted surveillance volume, the sample data concentrations, and sample data derived density were used in calculating the sample-based inventories. The surveillance volume, the flowsheet concentrations (and other data, such as heat load estimates and 1995 sample data), and sample-based density was used in calculating the engineering assessment-based inventories. The HDW model-based inventories used its internal reference bases.

5. All acetate, K, and NO_3 were dissolved in the interstitial liquid. Al, Cr, PO_4, OH, and F partition between the liquid and solid phases.

6. Concentration of components in interstitial liquid is based on a void fraction of 0.823 for HS/SSW. Those components were not lost with the evaporation of the supernatant and interstitial liquid.

E3.4 CONCENTRATION AND PARTITION FACTORS FOR HOT SEMIWORKS/ STRONTIUM SEMIWORKS WASTE IN TANK 241-C-201

One method for estimating a component inventory for a particular waste type in a tank (e.g., 1C waste) is to derive a concentration factor (CF) for that component. This approach was used to estimate selected analyte inventories in tank 241-C-201. Concentration factors are a means of reconciling process-based information and sample-based information for particular waste types. The CF is derived by dividing the concentration of a component found in the tank samples by the concentration of that component in the neutralized process waste stream (i.e., flowsheet concentrations in Table E3-4).

The CF for components of a defined waste are best determined if the tank contains only one waste type (e.g., only 1C waste in tank 241-T-104 or only HS/SSW waste in tank 241-C-201) and when abundant analytical data are available. The relative concentrations of components expected to precipitate essentially 100 percent to the waste solids (e.g., Ba, Ca, Ce, Fe, Pb, Sr) should be approximately proportional to the respective flowsheet concentrations for those components. That is, these components should exhibit nearly the same CFs, assuming that they are fully retained in the tank. If this is the case, it can generally be concluded that the sample data are consistent with the flowsheet basis and thus, are quite representative of the tank contents.

Based on known chemistry of these components in alkaline solutions it is expected that the components do indeed precipitate approximately 100 percent. Based on the process history and assumptions regarding flow behavior in this tank, the HS/SSW solids are assumed to be fully retained. The variation in CFs is attributable to sample inhomogeneity and/or laboratory analytical error.

Because the CFs are often consistent for the same waste type in different tanks, inventories for components in tanks that do not have samples can be estimated if it is known that the defined waste is indeed present in the tank, and the volume of the defined waste is known or can be predicted. Concentration factors can be quite different for different waste types. For example the CF based on Bi for $BiPO_4$ process 224 waste is 95, but for 2C waste the CF is approximately 20.

The following procedure is used to calculate the CF for iron in tank 241-C-201. From the data in Appendix B, the analytical-based inventory for Fe is 550 kg, which corresponds to a Fe concentration in the solids of 1.29*M*. The flowsheet concentration for Fe is 0.03*M* (Table E3-4). The CF_{Fe} is:

$$\frac{1.29 \text{ moles Fe/L}}{0.03 \text{ moles Fe/L}} = 43$$

Thus, a CF of 43 is estimated for the insoluble components of HS/SSW in tank 241-C-201.

Components assumed to precipitate (Ba, Ca, Ce, Fe, OH, Pb, Sr)

Ba:	2.0 E-04 moles_{Ba}/L x 2 kgal x 3,785 L/kgal x 137 g/mole_{Ba} x 43 CF x MT/1 E+06 g = 0.009 MT
Ca:	0.0049 moles/L x 2 kgal x 3,785 L/kgal x 40 g/mole x 43 CF x MT/1 E+06 g = 0.064 MT
Ce:	0.078 MT
Fe:	Basis analyte, 0.55 MT
Pb:	2.29 MT
Sr:	0.014 MT

Components assumed to remain dissolved in the interstitial liquid (Acetate, K, NO_3)

Acetate:	1.34 moles/L x 2 kgal x 3,785 L/kgal x 59 g/mole x $0.823_{porosity}$ MT/1 E+06 g = 0.492 MT
K:	0.019 MT
NO_3:	0.810 MT

Once the CFs for fully precipitated components for a waste type are determined, the sample analysis can be used to establish how other components partition between solids and supernatants. Concentration factors for components not expected to precipitate 100 percent can be ratioed to CF_{Fe} to obtain the partitioning factors (PFs) for those components. The PF for any component N, defined as CF_N/CF_{Fe}, is the fraction of N partitioned to the sludge. Using this method, the PF for other components for HS/SSW waste for tank 241-C-201 can be determined.

Components assumed to partition between aqueous and solid phases (Na, OH)

The CF_{Na} is: $\dfrac{1.37\ \text{moles}_{Na}/L}{4.9\ \text{moles}_{Na}/L} = 0.28$

The PF_{Na} is: $\dfrac{CF_{Na}}{CF_{Fe}} = \dfrac{0.28}{43} = 0.007$

$Na_{(solids)}$: 4.9 moles_{Na}/L x 2 kgal x 3,785 L/kgal x 23 g/mole_{Na} x 43 (CF) x 0.007 (PF) x MT/1 E+06 g = 0.257 MT

$Na_{(interstitial)}$: 4.9 moles_{Na}/L x $0.823_{porosity}$ (Agnew et al. 1997a HS waste type) x 3,785 L/kgal x 2 $\text{kgal}_{C\text{-}201\ waste}$ x 23 g/mole_{Na} x 0.993 (1-PF) x MT/1 E+06 g = 0.697 MT

Total Na: 0.954 MT

The CF_{OH} is: $\dfrac{0.34\ \text{moles}_{OH}/L}{1.32\ \text{moles}_{OH}/L} = 0.258$

The PF_{OH} is: $\dfrac{CF_{OH}}{CF_{Fe}} = \dfrac{0.258}{43} = 0.006$

$OH_{(solids)}$: 1.32 moles_{OH}/L x 2 kgal x 3,785 L/kgal x 17 g/mole_{OH} x 43 (CF) x 0.006 (PF) x MT/1 E+06 g = 0.044 MT

$OH_{(interstitial)}$: 1.32 moles_{OH}/L x $0.823_{porosity}$ x 3,785 L/kgal x 2 $\text{kgal}_{C\text{-}201\ waste}$ x 17 g/mole_{OH} x 0.994 (1-PF) x MT/1 E+06 g = 0.139 MT

Total OH: 0.183 MT

Estimated component inventories from this independent evaluation are compared with sample- and HDW-based inventories for selected components in Table E3-5. The engineering evaluation-based estimates also used surveillance data and data gathered from the 1995 sampling effort to derive estimates. Observations regarding these inventories are noted by component in the following text.

Table E3-5. Comparison of Selected Component Inventory Estimates for Tank 241-C-201 Waste.

Component	Engineering evaluation (MT)	1978 Sample-based[a] (MT)	HDW estimated[b] (MT)
Ba	0.009	NR	NR
Ca	0.064	NR	0.0134
Ce	0.078	NR	NR
Acetate	0.492	NR	0.094
Fe	0.545	0.545	1.22
K	0.019	0.00352	0.011
Na	0.954	0.238	0.599
NO_3	0.810	0.291	0.017
Pb	2.29	NR	0.119
Sr	0.014	NR	0
H_2O (percent)	10.6[c]	68.0	45.4
Radionuclide	(Ci)	(Ci)	(Ci)
^{90}Sr	17,100[d]	360	30,700
^{137}Cs	NR	67.5	9.08
$^{239/240}$Pu	146[e]	0.02	16.5

HDW = Hanford Defined Waste
MT = Metric ton
NR = Not reported
[a] Derived from Appendix B for sample obtained in 1978
[b] Agnew et al. (1997a), decayed to January 1, 1994
[c] Based on thermogravimetric analyses of the 1995 auger samples (Schreiber 1995)
[d] Based on tank heat load (Kummerer 1995)
[e] Based on total alpha analyses for the 1995 auger samples (Schreiber 1995).

E3.5 DOCUMENT ELEMENT BASIS

This section compares the sample-based estimate, the engineering assessment, and the inventory estimate calculated by the HDW model for selected analytes. Many of the differences observed between the estimates can be attributed to the differences in their respective mass bases. In other cases, the source term for the analyte in the waste type does not appear to be accurately or completely described. Several analytes such as aluminum, bismuth, chloride, chromium, fluoride, potassium, silicon, zirconium, and uranium are not principal process chemicals in the HS/SSW waste and are not expected to be present.

Barium. No comparison with the other estimation methods is possible because barium is not tracked by Agnew et al. (1997a), or reported in the 1978 sample data (Horton 1978). There is a trace amount of barium in this tank.

Nitrate. Wide variation is observed between the three estimates. The HDW estimated inventory is 48 times smaller than the engineering evaluation, and 17 times smaller than the sample-based estimate. The reason for the disagreement between the HDW estimate and the other two methods is not clear; however, it is probably the result of a source term discrepancy.

Calcium. The HDW estimated inventory is smaller than the engineering estimate, however both indicate that calcium is a relatively small contributors to the waste.

Cerium. No comparison with the other estimation methods is possible because cerium is not tracked by Agnew et al. (1997a), or reported in the 1978 sample data (Horton 1978). Based on the assumption that all of the cerium from the HS/SSW flowsheet precipitated, there is a trace amount of cerium in this tank.

Acetate. Wide variation is observed between the estimates. The HDW estimated inventory is five times smaller than the engineering evaluation. Current sample data from TOC and DSC results support a relatively high energetic organic content.

Iron. Modest variation is observed between the three estimates. The HDW estimated inventory is twice the engineering evaluation. Because of the dependence of the concentration factor on iron sample and flowsheet data, there is no discrepancy between the engineering evaluation and sample data derived estimates. However, the differences between the cited flowsheet and the HDW flowsheet could account for the observed variation between the HDW estimate and the other estimates.

Sodium. Modest variation is observed between the three estimates. The HDW estimated inventory is nearly twice as small as the engineering evaluation, and is three times as large as the sample-based estimate.

Total Hydroxide. Once the best-basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valences of other analytes. In some cases, this approach requires that other analyte (e.g., sodium or nitrate) inventories be adjusted to achieve the charge balance. During such adjustments, the number of significant figures is not increased. This charge balance approach is consistent with that used by Agnew et al. (1997a).

Lead. Wide variation is observed between the two estimates. No sample data estimate is available. The HDW estimated inventory is almost 20 times smaller than the engineering evaluation. Most of this discrepancy is attributable to the order of magnitude difference between the engineering evaluation and HDW flowsheet concentrations. The flowsheet composition supports a modest to high amount of lead in the waste.

Strontium. No comparison with the other estimation methods is possible. Non-radioactive strontium is considered to be zero in Agnew et al. (1997a), and it is not reported in the 1978 sample data (Horton 1978). There is a trace amount of strontium in this tank.

Water. Wide variation is observed between the three estimates. The HDW estimated inventory and 1978 sample-based estimate are relatively close; however, the current sample data and tank observations support a much lower water content for the tank. The tank has dried over time, thus most of the water and other volatiles have been lost. Any partially or totally soluble analytes that were dissolved in the interstitial liquid have precipitated and are part of the waste solids.

Strontium-90. Wide variation is observed between the three estimates. The HDW estimated inventory is almost twice as large as the engineering evaluation, based on the heat load in the tank derived from its dome temperature (Kummerer 1995). The engineering estimate is 47 times larger than the sample-based estimate. Current sample data appear to be biased low because of waste heterogeneity.

Cesium-137. Wide variation is observed between the two estimates. No basis for an engineering estimate is available. The HDW estimated inventory is over 7 times smaller than the sample-based estimate. The sample data supports a modest amount of ^{137}Cs in the waste.

Total Alpha/Plutonium-239/240. Wide variation is observed between the three estimates. The 1978 sample data based estimate provides an extremely low value, nearly 3 orders of magnitude smaller than the HDW estimate. The HDW estimated inventory is almost 9 times smaller than the 1995 sample-based estimate. The 1995 sample data supports a relatively high inventory of an alpha emitter in the waste. This alpha emitter is conservatively assumed to be $^{239/240}Pu$, however there is no quantitative measurement of any of the individual alpha emitters.

E4.0 DEFINE THE BEST-BASIS AND ESTABLISH COMPONENT INVENTORIES

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of chemical information for tank 241-C-201 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.

The results from this evaluation support using the sample data-derived evaluation where possible as the best-basis value for tank 241-C-201 in most cases. However because of the limited amount of data from both the samples and process history, the observed heterogeneity of the sample, and the wide variations in estimates that were derived from the three methods, there is no best source of estimates.

Best-basis inventory estimates for tank 241-C-201 are presented in Tables E4-1 and E4-2. The projected inventory is primarily based on a sample data-based evaluation of the tank, however engineering estimates and HDW model values have been presented because of the incompleteness in the data. The radionuclide inventories shown in Table E4-2 are based on the 1978 core sample results decayed to January 1, 1994, and Agnew et al. (1997a) HDW model estimates.

The inventory values reported in Tables E4-1 and E4-2 are subject to change. Refer to the Tank Characterization Database (TCD) for the most current inventory values.

Best-basis tank inventory values are derived for 46 key radionuclides (as defined in Section 3.1 of Kupfer et al. 1997), all decayed to a common report date of January 1, 1994. Often, waste sample analyses have only reported ^{90}Sr, ^{137}Cs, $^{239/240}Pu$, and total uranium (or total beta and total alpha), while other key radionuclides such as ^{60}Co, ^{99}Tc, ^{129}I, ^{154}Eu, ^{155}Eu, and ^{241}Am, etc., have been infrequently reported. For this reason it has been necessary to derive most of the 46 key radionuclides by computer models. These models estimate radionuclide activity in batches of reactor fuel, account for the split of radionuclides to various separations plant waste streams, and track their movement with tank waste transactions.

These computer models are described in Kupfer et al. (1997), Section 6.1, and in Watrous and Wootan (1997). Model generated values for radionuclides in any of 177 tanks are reported in the HDW Rev. 4 model results (Agnew et al. 1997a). The best-basis value for any one analyte may be either a model result or a sample or engineering assessment-based result if available. No attempt has been made to ratio or normalize model results for all 46 radionuclides when values for measured radionuclides disagree with the model. For a discussion of typical error between model derived values and sample-derived values, see Kupfer et al. (1997), Section 6.1.10.

Table E4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-C-201 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (kg)	Basis (S, M, E or C)[1]	Comment
Al	14.1	S	
Bi	0	M	
Ca	64	E	
Cl	17.6	S	
TIC as CO_3	176	S	
Cr	1.18	S	
F	4.39	S	
Fe	545	S	
Hg	0	M	
K	10.9	M	
La	0	M	
Mn	0	M	
Na	238	S	
Ni	70.5	S	
NO_2	8.82	S	
NO_3	291	S	
OH	222	C	
Pb	2,290	E	
PO_4	1,290	S	
Si	32.9	S	
SO_4	53.0	M	
Sr	0	M	
TOC	18.2	S	
U_{TOTAL}	0.583	S	

Table E4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-C-201 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (kg)	Basis (S, M, E or C)[1]	Comment
Zr	0	M	

[1]S = Sample-based
M = Hanford Defined Waste model-based, Agnew et al. (1997a)
E = Engineering assessment-based
C = Calculated by charge balance; includes oxides as hydroxides, not including CO_3, NO_2, NO_3, PO_4, SO_4, and SiO_3.

Table E4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-C-201, Decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	0.00441	M	
^{14}C	0.0114	M	
^{59}Ni	0.423	M	
^{63}Ni	41.5	M	
^{60}Co	0.00136	M	
^{79}Se	0.00521	M	
^{90}Sr	17,100	E	From estimate of 1994-95 heat load
^{90}Y	17,100	E	Based on ^{90}Sr
^{93}Zr	0.0231	M	
^{93m}Nb	0.0195	M	
^{99}Tc	0.0168	M	
^{106}Ru	9.41 E-06	M	
^{113m}Cd	0.0587	M	
^{125}Sb	0.00466	M	
^{126}Sn	0.00828	M	
^{129}I	3.18 E-05	M	
^{134}Cs	4.52 E-06	M	
^{137}Cs	42.7	S	1978 sample data = 67.5 Ci
^{137m}Ba	40.4	S	Based on ^{137}Cs
^{151}Sm	19.5	M	
^{152}Eu	0.325	M	
^{154}Eu	0.191	M	
^{155}Eu	21.2	M	
^{226}Ra	3.72 E-05	M	
^{228}Ra	2.09 E-10	M	
^{227}Ac	1.81 E-04	M	
^{231}Pa	6.06 E-06	M	

Table E4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-C-201, Decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{229}Th	3.79 E-08	M	
^{232}Th	6.65 E-13	M	
^{232}U	6.16 E-06	M	
^{233}U	3.69 E-07	M	
^{234}U	0.520	M	
^{235}U	0.0234	M	
^{236}U	0.00332	M	
^{238}U	0.526	M	
^{237}Np	7.71 E-05	M	
^{238}Pu	0.335	M	
$^{239/240}$Pu	146	S	Based on total alpha; Schreiber (1995)
^{241}Pu	24.2	M	
^{242}Pu	1.19 E-04	M	
^{241}Am	4.78	M	
^{243}Am	1.15 E-04	M	
^{242}Cm	0.00770	M	
^{243}Cm	4.22 E-04	M	
^{244}Cm	2.05 E-04	M	

[1]S = Sample-based
M = Hanford Defined Waste model-based, Agnew et al. (1997a)
E = Engineering assessment-based.

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E5.0 APPENDIX E REFERENCES

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